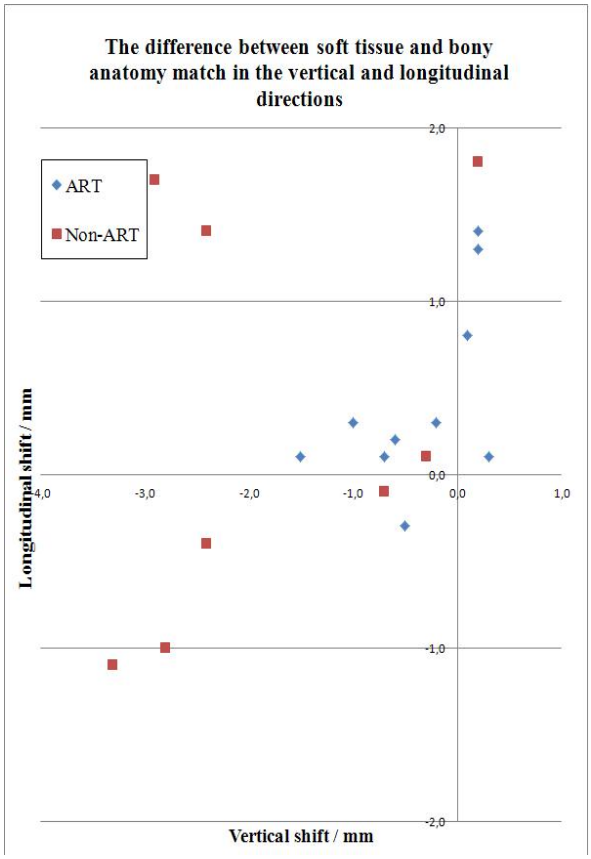

EP-1515

Evaluation of organ motion and uterine dose summation for IMRT in locally advanced cervical cancer

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Purpose/Objective: Interfractional changes in target and organ position and shape during external beam radiotherapy (EBRT) of cervical cancer patients may be of significant magnitude (Figure 1). To compensate for motion, application of relatively large CTV-PTV margins is often applied, which can reduce the clinical advantages of e.g. IMRT. The study aimed to evaluate the patterns of target and organ motion during EBRT and to evaluate the impact on dose delivery with specific focus on dose to the uterine body.

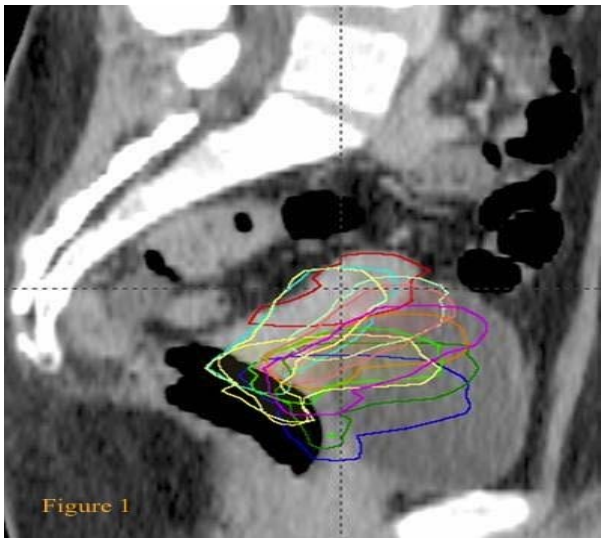
Materials and Methods: Ten patients with locally advanced cervical cancer treated with chemoradiation and brachytherapy were analysed. EBRT was delivered as 45-50 Gy in 25-30 fractions using daily online cone beam computed tomography (CBCT) for patient set up. Treatment was in supine position, and a drinking protocol was applied to obtain a full bladder. The clinical target volume (CTV) encompassed the gross tumour volume (GTV), cervix, parametrium, uterus, upper vagina and the nodal CTV. Cervix/uterus as well as bladder and rectum were delineated on each CBCT, and transferred to the planning CT. The impact of a reduced margin strategy of 0.5 cm CTV-PTV for the uninvolved uterus was compared to our standard of 1.5 cm. Uterus DVH parameters were extracted for each fraction and D98 was summed for both scenarios with evaluation of the percentage of fractions where D98 was less than 95% and 90% of prescribed dose. Bladder volume was assessed for each fraction to analyse for time trends and to evaluate a correlation between uterine coverage and bladder volume.

Results: In 6/10 patients the uterus D98 was at least 95% of prescribed dose in at least 92% of all fractions for the reduced margin strategy. In the remaining 4 patients the D98 was less than 95% in at least 5 fractions for the reduced margin strategy. In 2/4 patients the lack of coverage was correlated with the bladder filling which was significantly different from the bladder volume in the treatment planning scan (p=0.001, p=0.02). In 2/4 patients there was no correlation between bladder volume and lack of coverage (p=0.33, p=0.19). For all patients and for both margin strategies, the fractional dose summation for uterus D98 was >90% which corresponded to at least 40.5 Gy (table 1).

	Standard margin			Reduced margin		
Patient	90%*	95%*	Sum.dose**	90%*	95%*	Sum. dose**
1	70	70	92.4	67	47	90.3
2	100	96	97.2	100	92	96.7
3	100	100	97.5	100	100	97.2
4	100	93	97.1	100	66	95.4
5	100	100	94.4	100	100	94.5
6	100	100	96.7	100	96	97.3
7	100	96	97.0	100	25	94.2
8	89	79	95.2	79	61	94.2
9	100	100	97.7	100	100	96.6
10	100	100	97.2	100	100	97.5

* % of fractions covering at least 98% of the uterine volume with at least 90% and 95% of prescribed dose respectively.
** Fractional dose summation for D98≥95%.

Conclusions: Treatment plans with standard margin and reduced margin were robust to organ motion in terms of fractional dose summation. The uterus D98 was at least 90% of prescribed dose for all patients. Taking into account that brachytherapy delivers additional 5-10 Gy to the uninvolved uterine body, the summed uterine dose will be well above 45Gy, which is often considered appropriate for targeting tissue at risk of microscopic spread. Dose coverage was partly but not consistently correlated to variation in bladder volume. This may indicate that an adaptive radiotherapy approach based on a library plan selection strategy should include evaluation of bladder volume and location of uterine body.



Electronic Poster: Physics track: Imaging: focus on clinical applications

EP-1516

Cherenkov imaging of IMRT/VMAT plans with high temporal and spatial resolution

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Purpose/Objective: Cherenkov emission from water tank is possible at 20 frames per second acquisition, and so this allows direct high resolution visualization of the delivery of IMRT and VMAT plans for the first time ever. This study focuses on the temporal and spatial capabilities of the first 2+D, and 3D Cherenkov water imaging systems.
Materials and Methods: Cherenkov emission was imaged from a standard water tank, with 1g/L quinine sulphate in solution. The emission was detected using a time-gated ICCD camera synchronized to the LINAC pulses at 200Hz. Images were collected at 20Hz with room lights on, using background acquisition and subtraction. 2+D imaging of TG-119 plans was done with imaging treatments from one perspective. 3D imaging was done for a static beam by rotating the water tank and camera through 360 degrees during imaging.
Results: 2+D imaging of delivery can be achieved with extremely high resolution (300 microns) using the appropriate lens and ICCD, and the ability to capture the volumetric temporal kinetics of delivery is unique to this type of imaging system. The agreement between Cerenkov image and dose map from the treatment planning system was greater than 96% from gamma analysis using a 3%/3mm criteria. 3D imaging of individual beams illustrates how high resolution features of the MLC can be captured, and even leakage radiation through the closed MLCs and the end leakage can be visualized with high SNR.
Conclusions: The niche area of Cherenkov imaging of IRMT/VMAT delivery in water tanks can allow for high resolution fast data acquisition. The agreement between Cherenkov emission and dose is very good, indicating it should be acceptable as a surrogate measure of dose under certain conditions.

EP-1517

Cervical tumour segmentation using multi-sequence MRI and linear discriminant analysis

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Purpose/Objective: Tumour delineation is a challenging and time-consuming part of radiotherapy planning. The task has become more complex with the increased popularity of multi-sequence and multimodal imaging. The purpose of this study was to investigate how we could combine images from different MR sequences and use them for automatic segmentation of cervical cancer tumours.
Materials and Methods: Seventy-eight patients with advanced cervical cancer where imaged using three different MRI sequences: T2-weighted MRI, T1-weighted MRI and dynamic contrast enhanced (DCE) MRI. These images were used separately or in combination as input to a Fisher's Linear Discriminant Analysis classifier. We trained the classifier to identify each voxel as either tumour or non-tumour, using the radiologist's delineations as ground truth. The segmentation results provided probability maps, giving the probability of each voxel belonging to the tumour. We used leave-one-patient-out cross-validation to assess the classifier's performance.
Results: The best segmentation model resulted in a Dice similarity coefficient of 0.37 and a Kappa value of 0.33 after cross-validation. This result is similar to the results from a previous study of agreement between radiologists. The DCE-MRI time series significantly improved tumour segmentation. The T1-weighted images gave a smaller, but also significant, increase in performance. Even though the radiologist used the T2-weighted images for delineation, these images did not improve the performance of the automatic segmentation model.
Conclusions: Our results suggest that DCE-MRI and T1-weighted MRI contain information relevant for automatic cervical tumour segmentation. The proposed method can easily be extended to include other image types, for example diffusion weighted MRI.

EP-1518

18F-NaF PET/CT-guided boost stereotactic body radiation therapy for bone metastases from prostate cancer

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